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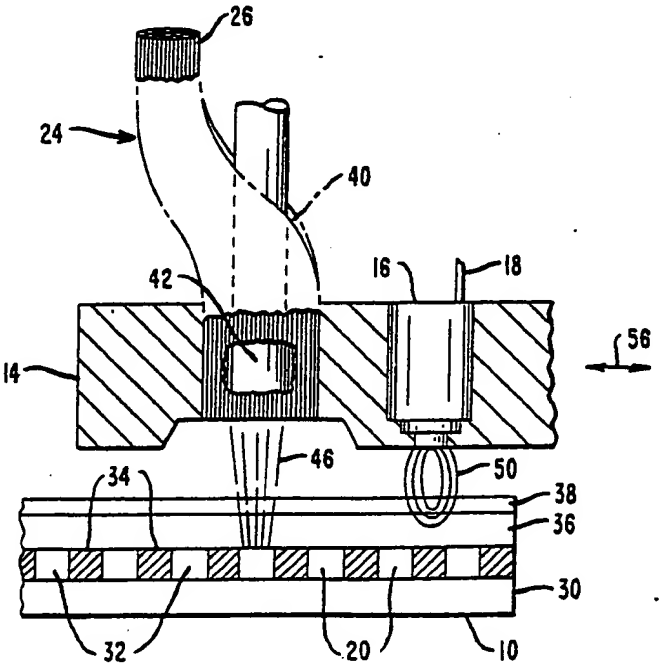
(54) Title: MAGNETIC RECORD MEDIUM AND APPARATUS AND METHOD FOR TRACKING THE SAME

(57) Abstract

An apparatus and method for selectively positioning a read/write head (14) adjacent a record medium (10) on which optical guidelines (20) have been recorded for magnetically reading or writing data on one of a plurality of data tracks thereon. Each data track is associated with one of the optical guidelines (20) and may include an identification optically coded therein. The apparatus includes a light source (26) for illuminating the record medium (10) adjacent the read/write head (14), and a light detector system (28) for detecting light reflected (46) from one of the optical guidelines (20). A servo mechanism (60) adjusts the position of the read/write head (14) responsive to reflected light (46) detected by the light detector system (28). Since the track information is recorded optically on the record medium (10), this allows for optical sensing which is most accurate and does not interfere with the magnetic reading/writing function of the head (14), and the medium is capable of carrying more magnetically recorded data information than conventional media of the same size.



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MAGNETIC RECORD MEDIUM AND APPARATUS AND METHOD FOR TRACKING THE SAME

Technical Field

The present invention relates to a magnetic record medium and to an apparatus having a read/write head for magnetically reading data from, or writing data on, said medium. In particular, the invention relates to a magnetic disk carrying a plurality of data tracks thereon, and to an apparatus and method for tracking a specified track on the magnetic disk.

Background Art

A problem arising with magnetic disks carrying a large amount of information in densely packed magnetic tracks is that it is rather difficult to ensure proper positioning of the read/write head to a desired track and to ensure accurate tracking once the selected track has been found.

In U.S. Patent No. 4,371,904 a flexible magnetic disk memory system is disclosed in which the magnetic disk includes alternate data sectors and positioning sectors for recording data information and positioning information respectively. Holes are punched in the magnetic disk and arranged such that when light shines through the hole to a light sensor in the disk drive, the positioning sectors are located under a read/write head in the disk drive, and circuitry is included to locate the read/write head over a specified data track during the time that the positioning sector is under the read/write head. Data from the corresponding data track is then retrieved from the magnetic disk memory from that data track during the tim that th data sector of the magnetic disk memory is passing under the read/write h ad.

In U.S. Patent No. 4,402,025 a "Winchester" magn tic disk drive is disclosed in which both data

and servo track information is magnetically recorded on th magnetic disk of the drive. Read/write heads and a s rvo head are provided for separately reading the magnetic information recorded on the disk, and a servo positioning mechanism is included to position the read/write heads over a specified data track responsive to servo track information read by the servo head. A magnetic shield is provided to prevent interference between data signals and servo track position signals.

A disadvantage of the above described arrangements is that data information and positioning information occupy different surface areas of the disk, whereby the space available for data information is greatly reduced.

Disclosure of Invention

It is an object of the invention to provide a magnetic record medium, as well as an apparatus and method for tracking the same, in which the above disadvantages are alleviated and which record medium is capable of carrying more data information than conventional record media of the same size.

Thus, according to the invention, there is provided a magnetic record medium for use with an apparatus having a read/write head for magnetically reading data from, or writing data on, said medium, which medium includes a substrate and magnetic material disposed on said substrate for carrying a plurality of data tracks thereon, characterized by a plurality of optical guidelines recorded on said record medium, one guideline being associated with each data track, said guidelines being useable by said apparatus for positioning said read/write h ad adjacent a selected on of said guid lines and for tracking the said guideline.

According to another aspect of the invention, there is provided an apparatus for selectively positioning a magnetic read/write head with respect to a record medium for magnetically reading or writing data in one of a plurality of data tracks thereon, characterized by light source means operatively positioned to illuminate optical guidelines recorded on said record medium, each being associated with one of said data tracks; light detector means operative for detecting reflected light from one of said optical guidelines; and servo means responsive to said light detector means and operative to adjust the position of said read/write head with respect to said record medium in response to reflected light received by said light detector means.

According to yet another aspect of the invention, there is provided a method of positioning a read/write head adjacent a record medium for reading or writing data thereon, characterized by the steps of placing optical guidelines on said record medium; illuminating said optical guidelines with light source means; detecting light reflecting from one of said optical guidelines; positioning said read/write head over the record medium in read/write relationship with a selected one of a plurality of data tracks on the record medium in response to the detection of the reflected light; and magnetically reading and writing data on one of a plurality of data tracks on the record medium wherein each of the data tracks is associated with one of said optical guidelines.

In the preferred embodiment of the invention, the magnetic record medium is a disk having said optical guidelines in the form of concentric circles thereon. Each guideline may be intermittently interrupted to provide line segments of different lengths representing a code which identifies the respective guideline and th magnetic track associated therewith.

Thus, it may be seen that, while the data information is recorded magnetically on the disk in a conventional manner, the track information is recorded optically which allows for optical sensing of a code indicative of the data track being read which is separate from, and does not cause interference which, the data signals being read from or written on the disk, thereby allowing data information and track information to overlap. Moreover, since the optical guidelines provide accurate tracking of the data tracks, the data tracks may be placed much closer together then when the read/write head is positioned by magnetic signals, thereby providing greatly increased data density on the disk of the same size.

Brief Description of the Drawings

Embodiments of the invention will now be described, with reference to the accompanying drawings, in which:-

Fig. 1 is an illustration of a magnetic disk and a read/write head in a disk drive of the present invention;

Fig. 2 is a partial cross-sectional view of the disk and read/write head of Fig. 1 taken along lines 2-2;

Fig. 3 is an illustration of a portion of a single guideline optically recorded on the disk of Fig. 1 and Fig. 2;

Fig. 4 presents a block diagram of a disk drive utilizing one embodiment of the present invention;

Fig. 5 is a plot of the light intensity reflected from a guideline optically recorded on the disk of the present invention;

Fig. 6 is a cross-sectional vi w of another mbodim nt of a lightpipe usable in the light detector system of the present invention; and

Figs. 7-10 are other embodiments of a portion of the optical system usable with the present invention for illuminating and viewing the optical guidelines.

Best Mode for Carrying out the Invention

Fig. 1 is an illustration of a magnetic disk and a read/write head of a disk drive utilizing the present invention. The illustrated disk 10 may be one of a number of recording media upon which data may be recorded, and is in the illustrated embodiment a magnetic disk usable in a "Winchester" disk drive, well-known in the art. As is known, the disk 10 is rotated very rapidly about its central hub 12 to "fly" the disk under a read/write head 14 in an aerodynamically stable condition such that data may be magnetically written on or read from the disk. This technique is well-known in the art and will not be further described.

The read/write head 14 includes a magnetic element 16 for reading or writing data on the disk 10, and includes a lead 18 for transmitting the data electronically as is known. The disk 10 has recorded on its surface a series of optical guidelines 20 which are usable, as will be explained, to position the read/write head 14 over a desired track of magnetically recorded data on the disk 10. The guidelines 20 which form concentric rings around the disk 10, are approximately 5 microns wide and are spaced in a density of approximately 5,000 per inch. Each guideline 20 is periodically interrupted as at 22 in such a manner as to contain an individual code for each guideline. Thus, not only does the guideline 20 serve to be used by the read/write head 14 to position the read/write head over a desired track of data, but the coding contained in each guideline 20 id ntifies the data track to which data is being written, or from which data is being read.

The disk drive may contain a plurality of disks stacked vertically one above the other and rotated simultaneously about the hub, as is well-known in the art. In that event, a like number of read/write heads will be positioned adjacent the recording surfaces of the disks, and electronic means will be included in the disk drive to read data from any desired track from any one of the disks in the stack. Also, in a system having a plurality of disks, each read/write head contains an optical system for detecting optical guidelines recorded on each of the disks in the system.

The read/write head 14 includes an optical system 24 for detecting the guidelines 20. A light source, such as clad illumination fibers, is provided to illuminate the surface of the disk 10, and an optical lightpipe, for instance a graded index fiber, 28 is provided for transmitting optical data to a proper detection circuit, as will be explained. Even though the term "optical" is used herein, it will be understood that the guidelines 20 and the detector therefor may be for radiation of any wavelength, and is not to be limited to the visual spectrum of light.

Fig. 2 is an illustration of a portion of the read/write head 14 and the magnetic disk 10 taken along line 2-2 of Fig. 1. The magnetic disk 10 includes an aluminum substrate 30 on which the optical guidelines 20 have been recorded. The optical guidelines are formed by recording alternate light and dark concentric circles on the aluminum substrate 30. The light portions 32 in the preferred embodiment are sensed by the optical system 24 by light reflection as will be described. It will be understood that the dark portions 34 could optionally be used by a suitable detection means inst ad of the light portions 32 as used herein. A layer of magnetic recording material 36 is deposited over th recorded guidelines as

shown, and a suitable protective coating layer 38 is provided over the entire surface of the disk 10. It will be understood that the protective layer 38 and the magnetic recording material layer 36 must be sufficiently transparent to allow easy detection of the recorded guidelines 20. In the case of certain magnetic recording material which is opaque, the guidelines 20 can alternately be recorded on the surface of the disk, as may be required.

Even though the system shown in Figs. 2 and 4 shows the optical system 24 arranged to read optical guidelines 20 on the same side of the disk 10 as the magnetically recorded data, the optical system 24 may be arranged such that the optical guidelines 20 are recorded on and read from the reverse side of the disk from the magnetically recorded data.

The optical system 24 extends through the read/write head 14 providing an optical path therethrough, and includes the lightpipe 28 positioned axially through the center of the optical system 24 as shown. The individual fibers of the illumination fibers 26 are distributed such as at 40 to be evenly positioned around the end 42 of the detector lightpipe 28 as shown. As will be understood, the illumination fibers 26 thus arranged provide an even illumination about the periphery of the lightpipe end 42, which illumination is transmitted downwardly onto the surface of the disk 10 to evenly illuminate the light portions 32 of the guideline 20 directly under the lightpipe 28. The ends of the light fibers 26 and the end 42 of the lightpipe 28 may be shaped and polished to focus the light on the surface of the disk 10. In the preferred embodiment, the light beam 46 reflected from an individual guideline 20 is focused on a spot approximately 5 microns in diameter such that when the read/write head is properly positioned over a guideline 20, the spot upon which the reflected

light beam 46 is focused will be completely contained within the width of the light portions 32 of a single guideline 20.

A conventional magnetic read/write element 16 is placed in the head 14 for magnetically writing to and reading from the disk 10. As is well-known, the read/write head 14 is placed a sufficient distance above the "flying" magnetic disk that magnetic lines of flux 50 form a magnetic circuit between the magnetic recording material layer 36 and the magnetic element 16 to access data recorded therein as controlled by proper electronic signals over line 18. The function of the magnetic element 16 and the magnetic reading and recording of data is conventional and well-understood in the art, and will not be explained further herein.

Referring to Fig. 3, each guideline 20 is formed by the light reflecting portion 32 recorded on the surface of the magnetic disk 10, and is bordered by dark portions 34. The disk 10 is moved past the read/write head 14 as shown by the arrow 52. The spot 54 is the spot previously mentioned upon which the reflected light beam 46 of Fig. 2 is focused. As shown in Fig. 3, the read/write head 14 is positioned to locate the spot 54 entirely within the light portion 32 of the guideline 20. The read/write head as moved in either the radially inward or outward direction as shown by double headed arrow 56 in Figs. 2, 3, 4 and 6.

Turning now to Fig. 4, the read/write head 14 is positioned over a disk 10 for magnetically reading and writing data recorded thereon as previously described from appropriate electronic data circuitry 59 in the disk drive in a conventional manner.

The positioning of the read/write head 14 in th radial direction, as shown by arrow 56, is accomplished by a conventional servo mechanism including a

servo motor 60 and a servo control circuit 62. A light source such as a laser or a light emitting diode (LED) source 63 is provided which directs light through an illumination conduit 64 to provide illumination on the surface of the magnetic disk 10. The illumination source 63 is powered by an appropriate illumination power circuit 66, dependent upon the type of light source 63 that is used. The illumination conduit 64 may be composed of fibers arranged similar to those of Fig. 2, or may extend directly through the read/write head 14 and be terminated by a lens 66 which focuses illumination on the surface of the disk 10 such that light reflected from a guideline 20 is directed into the detector lightpipe 70 in the same manner as discussed in connection with Fig. 2. The lightpipe 70 may be a graded index fiber as discussed in connection with lightpipe 28 of Fig. 2. The optical path from the lightpipe 70 to a detector circuit may be any one of a number of known arrangements, and is shown diagrammatically as a mirror 72 which reflects light 74 from the lightpipe 70 to an optical detector 76.

The optical detector 76 may be any one of a number of photodetectors known in the art which produce an electrical signal responsive to being struck by light. The photodetector 76 features a pair of detector units 80 and 82. The detector unit 80 is connected by conductor 84 to an amplifier 86 which is in turn connected to the servo control circuit 62. The detector unit 82 is connected by a conductor 88 to an amplifier 90 which is also connected to the servo control circuit 62. The electrical signal coming from amplifier 86 is compared to the electrical signal coming from amplifier 90 to give an error signal which is us d in a conventional manner by the servo control circuit 62 to transmit correction signals over conductor 92 to the servo motor 60 to make adjustments in

th positioning of the read/write head 14. These adjustments position the read/write head 14 over a desired track as shown and discussed in connection with Fig. 3.

The detector unit 80 is connected to a summing circuit 94 by a conductor 96, and the detector element 82 is connected to the summing circuit 94 by a conductor 98. The output of summing circuit 94 is fed to a decoding circuit 100 which decodes the intermittent portions 22 of the guideline 20 shown in Fig. 1, for determining which guideline the read/write head 14 is positioned over.

The track identification of the track being read is fed to the servo control circuit 62 by conductor 102 as shown. A desired track identification is also supplied to the servo control circuit 62 from the magnetic disk circuitry or an appropriate computer processor over a conductor 104 for comparison with the track identification supplied by track decoding circuit 100. If the track identification from conductor 102 and 104 are not identical, or a new desired track identification is received over conductor 104, the servo control circuit 62 generates appropriate control signals over conductor 92 to the servo motor 60 to reposition the read/write head 14 over the desired track. The electrical signals from amplifiers 86 and 90 are then used as previously described to hold the read/write head 14 over the desired data track.

Fig. 5 is a plot of the light intensity 110 across the width of the light reflecting portion 32 of one of the guidelines 20. The light intensity 110 is highest at the very center of the light reflecting area 32 as shown at axis 112 of Fig. 5. The light intensity 110 dr ps off as shown with the distance in either direction from the center of light reflecting area 32 as represented by "d" in Fig. 5. The spot 54 upon which the optical system is focused is arranged

to fall, when aligned properly, on desired points on the light intensity curve 110 such as the one-half intensity points 118 and 120. Thus, if the spot 54 is positioned in the exact center of 32 as shown in Fig. 3, the light received by each detector unit 80 and 82 will be equal to the shaded area under each half of the curve 110 from the center line 112 to the points 118 and 120 respectively. If the read/write head 14 drifts with relationship to the magnetic disk 10, and the spot 54 is no longer centered in area 32, the light received by each detector will no longer be equal. For instance, if the spot 54 wanders such that its center is displaced from the center of the area 32, the light received by the detector units 80 and 82 will no longer be equal. Thus, referring back to Fig. 4, the signal from amplifier 86 will not be equal to the signal from amplifier 90 and the servo control circuit 62 will generate an error signal, causing the servo motor 60 to move the read/write head 14 in the direction needed to again make the signals from amplifiers 86 and 90 equal. Servo mechanisms to effect such corrections are old and well-known in the art.

To better distinguish the separate optical signals received by the detector units 80 and 82, a divided lightpipe 120 shown in Fig. 6 may be substituted for the lightpipe 70 of Fig. 4 or the lightpipe 28 of Fig. 2. The lightpipe 120 is divided, providing a first light conduit 122 and a separate second light conduit 124 over which light signals may be transmitted. The lightpipe 120 is oriented in the read/write head 14 such that the servo motor moves the lightpipe 120 in the direction of the arrow 56.

Figs. 7-10 are other embodiments of the illumination and viewing portion of optical systems usable with the present invention. In Fig. 7, a single lightpipe is used to both illuminate and view the surface of the disk 10. In this case, a single

lightpipe 130 is used which is a step index optical fiber which both conducts illumination light to the surface of the disk 10, and which returns light reflected from the disk 10 to the optical sensors discussed earlier. A lens 132 is provided to focus the light on a spot 54 as discussed in connection with Fig. 3.

In Fig. 8, the lightpipe for conducting light reflected from the disk 10 to the sensors discussed in connection with Fig. 4 includes a step index optical fiber 140 whose end 142 is optically connected to a length of graded index fiber 144. The graded index fiber 144 acts as a lens to focus the view of the lightpipe on a spot as previously discussed.

Fig. 9 illustrates a lightpipe which has a central core 150 made up of a graded index optical fiber, and which is clad by a layer of step index optical fiber 152. An illuminating source 154 powered by an appropriate power source 156, is optically connected to the layer 152 for illuminating the layer 152, which in turn illuminates the surface of the disk 10. The graded index fiber optic core 150 focuses the view of the lightpipe on a spot on the disk 10 as previously discussed.

Fig. 10 illustrates an overfilled aperture in which a beam of light is used to both illuminate the disk 10, and to view light reflected from the disk 10 carrying the image of guidelines recorded thereon. A read/write head 160, similar to the read/write head 14 shown in Fig. 1, has an aperture 162 axially therethrough. A light beam 164 is directed through the aperture to illuminate the disk 10, and a lens 166 is centered in the aperture 162 to focus the view of the light beam on a spot on the disk 10 as previously described. In the case of the embodiment shown in Fig. 10, the atmosphere itself is used to conduct th light beam, and a mirror, such as the mirror 72 shown

in Fig. 4, must be accurately aligned with the aperture to direct light reflected from the disk 10 to sensors as described in connection with Fig. 4.

WHAT IS CLAIMED IS:

1. A magnetic record medium (10) for us with an apparatus having a read/write head (14) for magnetically reading data from, or writing data on, said medium (10), which medium includes a substrate (30) and magnetic material (36) disposed on said substrate for carrying a plurality of data tracks thereon, characterized by a plurality of optical guidelines (20) recorded on said record medium (10), one guideline (20) being associated with each data track, said guidelines (20) being useable by said apparatus for positioning said read/write head (14) adjacent a selected one of said guidelines (20) and for tracking the said guideline (20).

2. A record medium according to claim 1 and being in the form of a disk (10), characterized in that said optical guidelines (20) are in the form of concentric circles on said substrate (30).

3. A record medium according to claim 2, characterized in that each guideline (20) is intermittently interrupted (at 22) to provide line segments of different lengths representing a code which identifies the respective guideline (20) and the magnetic track associated therewith.

4. A record medium according to claim 2, characterized in that said guidelines (20) are recorded on said substrate (30) and have said magnetic material (36) deposited thereon, said magnetic material (36) being transparent to allow reading of said optical guidelines (20) by said apparatus.

5. An apparatus for selectively positioning a magnetic read/write head (14) with respect to a

record medium (10) for magnetically reading or writing data in one of a plurality of data tracks thereon, characterized by light source means (26, 63, 64, 66) operatively positioned to illuminate optical guid - lines (20) recorded on said record medium, each being associated with one of said data tracks; light detector means (28, 70, 76) operative for detecting reflected light (46, 74) from one of said optical guidelines (20); and servo means (60) responsive to said light detector means (28, 70, 76) and operative to adjust the position of said read/write head (14) with respect to said record medium (10) in response to reflected light (46, 74) received by said light detector means (28, 70, 76).

6. An apparatus according to claim 5, characterized in that said light detector means includes an optic fiber (28) and that said light source means includes a plurality of separate illumination fibers (26), said illumination fibers (26) being distributed at least at one end (42) around the periphery of the optic fiber (28) of said light detector means for providing illumination on the record medium (10) positioned adjacent said read/write head (14).

7. An apparatus according to claim 5, further characterized by decoding means (100) for decoding guidelines identification information represented by the guidelines (20) on the record medium (10).

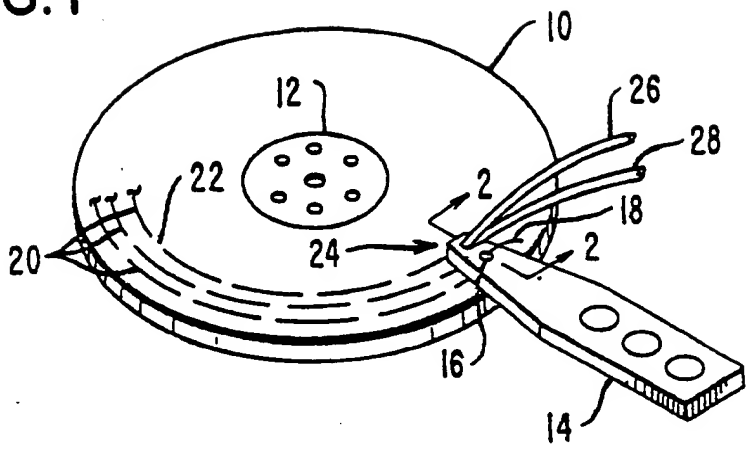
8. An apparatus according to claim 7, further characterized by means for indicating a guideline (20) associated with a desired data track on the record medium (10), means for comparing the desired guid line identification with the present guideline identification from said decoding means (100), and

means (62) operatively connected to said servo means (60) for controlling said servo means (60) to move the position of the read/write head (14) from the present guideline (20) to the desired guideline (20).

9. An apparatus according to claim 5, characterized in that said light detector means (76) includes a pair of light sensing elements (80, 82) and a divided lightpipe (120) having two separate light transmission paths (122, 124), each of said light transmission paths being optically coupled to one of said light sensing elements (80, 82), each light sensing element having an input operative for receiving light (74) reflected from one of said optical guidelines (20) and an output operative for generating an electrical signal dependent on the light striking said input; and in that said servo means (60) includes comparison means (62) for comparing the electric signals on the outputs of said light sensing elements (80, 82), and correction means responsive to said comparison means for adjusting the position of the read/write head (14) until the electric signals from said light sensing element (80, 82) outputs are equal.

10. A method of positioning a read/write head adjacent a record medium for reading or writing data thereon, characterized by the steps of placing optical guidelines on said record medium; illuminating said optical guidelines with light source means; detecting light reflected from one of said optical guidelines; positioning said read/write head over the record medium in read/write relationship with a selected one of a plurality of data tracks on the record medium in response to the detection of the reflected light; and magnetically reading and writing data on one of a plurality of data tracks on the record medium wherein each of the data tracks is associated with one of said optical guidelines.

FIG. 1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12
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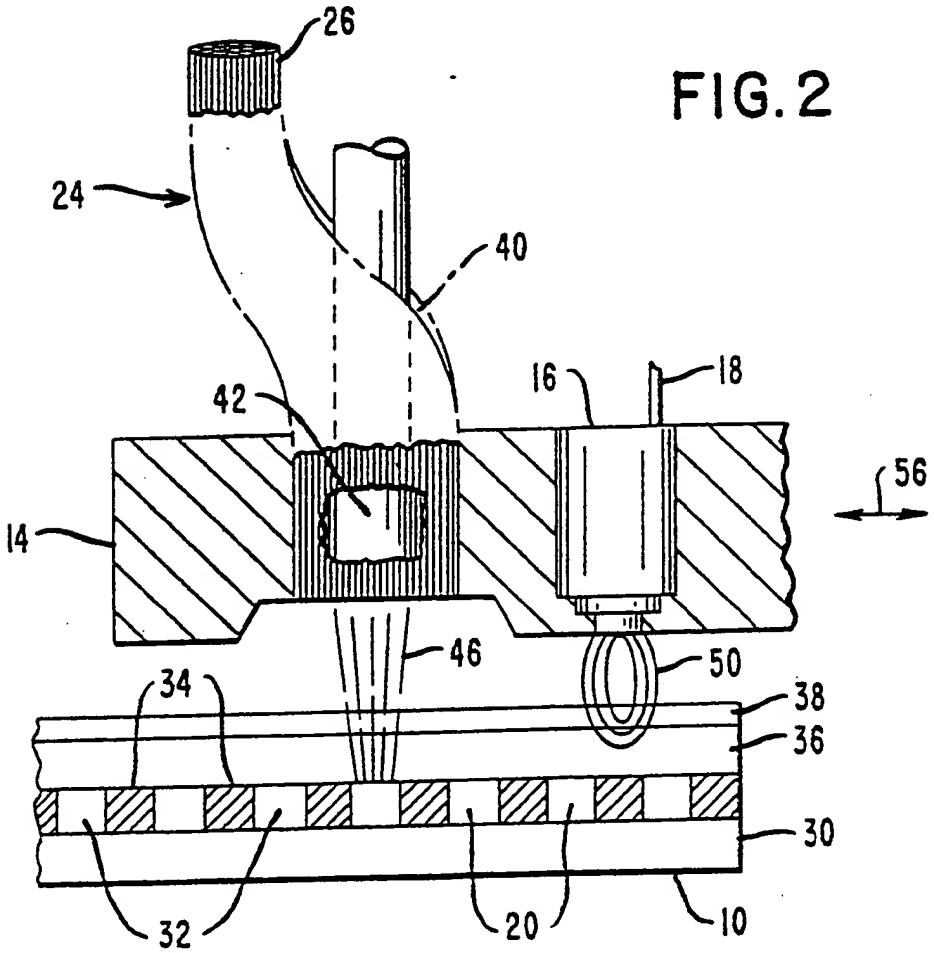
16
14

FIG. 2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32
20
10

FIG. 3

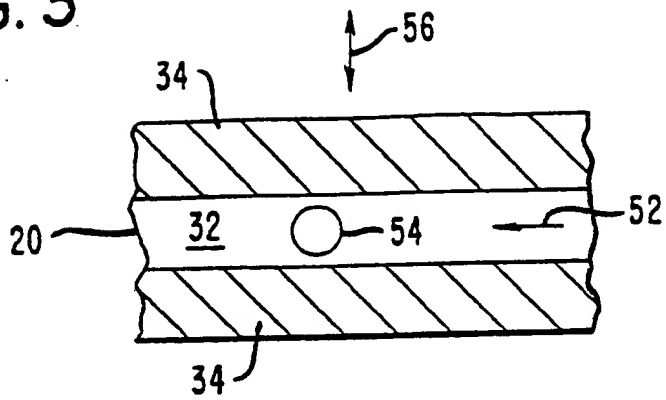


FIG. 6

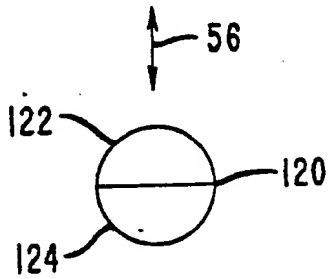
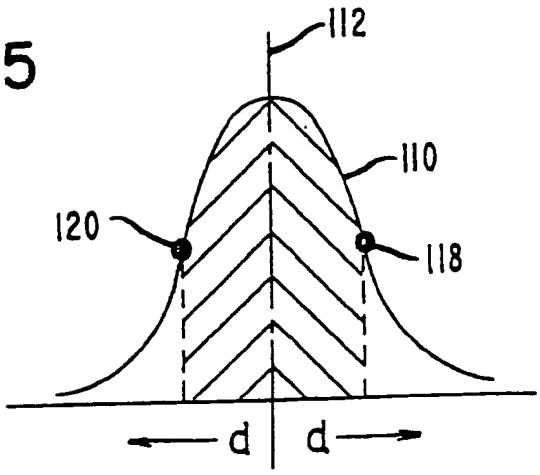
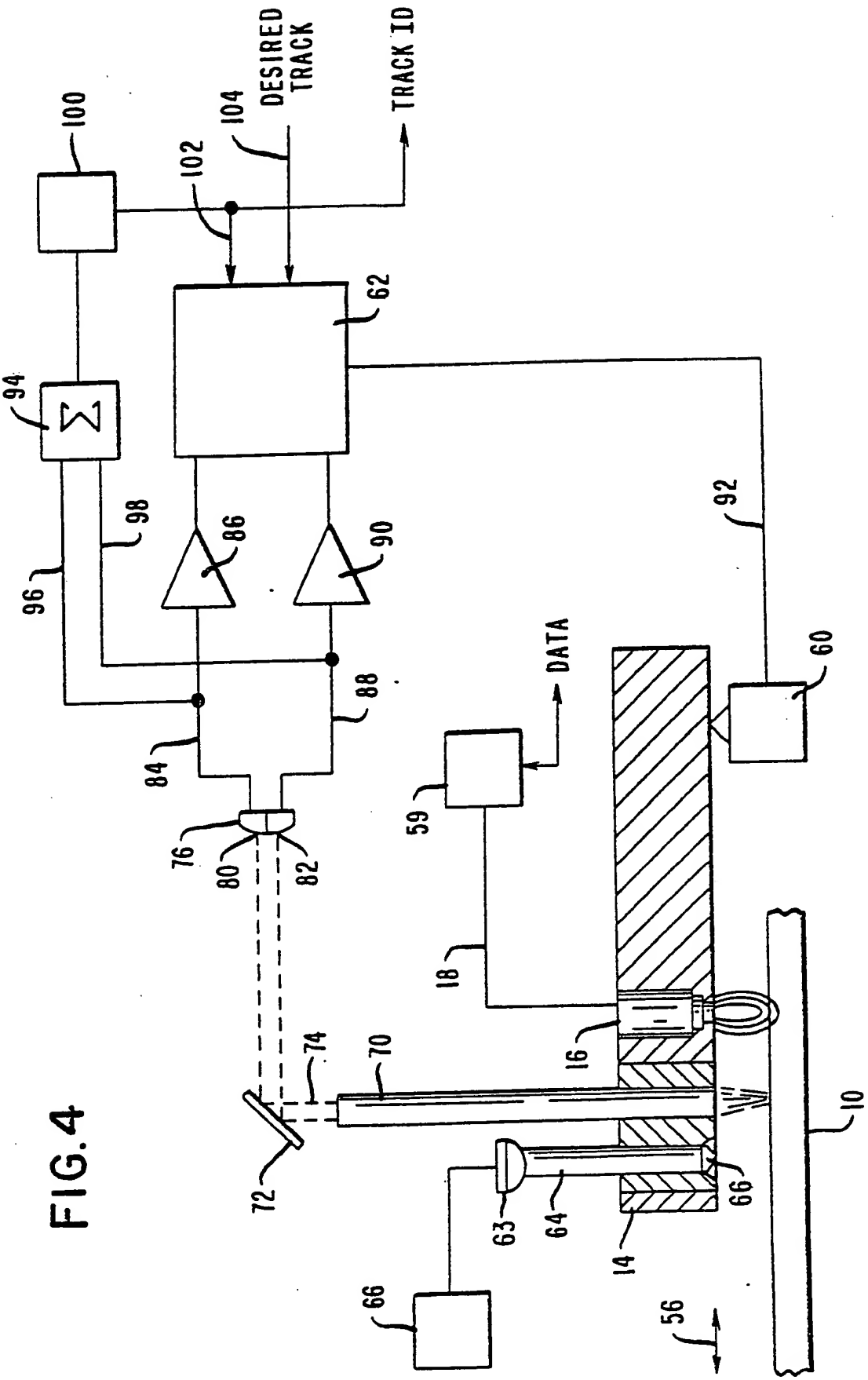


FIG. 5

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TRACK ID
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92
88
84
76
80
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16
74
70
72
10
63
64
66
14
66
56

FIG.4

FIG. 7

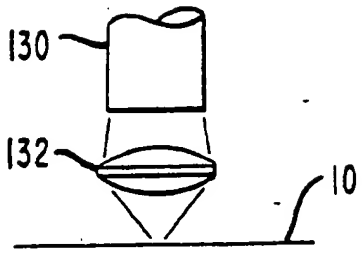


FIG. 8

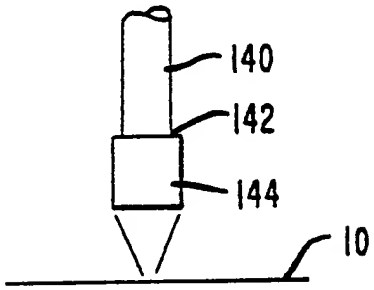


FIG. 9

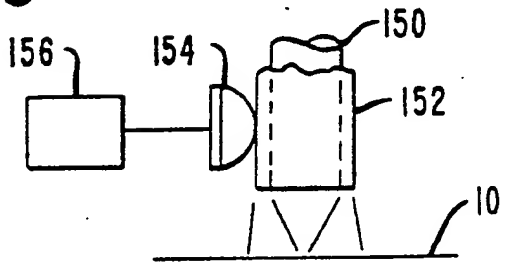
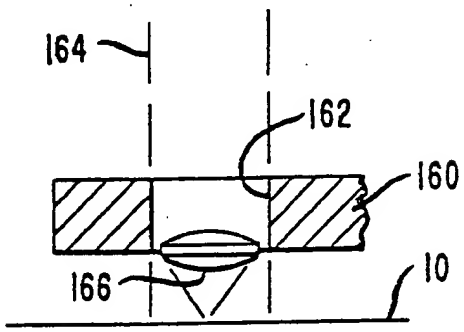


FIG. 10



INTERNATIONAL SEARCH REPORT

International Application No PCT/US 84/02085

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]:- G 11 B 5/596; G 11 B 21/10

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	G 11 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	IEEE-Transactions on Magnetics, vol. MAG-16 no. 5, September 1980 (New York, US) N. Koshino et al.: "Optical method of the head positioning in magnetic disk systems", pages 631-635, see the entire article	1,2,4-6,9,10
X	IBM Technical Disclosure Bulletin, vol. 25, no. 12, May 1983 (New York, US) pages 6432-6433, see the entire article	1,4,5,9,10
X	FR, A, 2347744 (PHILIPS) 4 November 1977 see page 2, line 9 - page 3, line 19; figures 1,2	1-5,9,10
X	FR, A, 2315142 (PYRAL) 14 January 1977 see page 2, lines 12-21; page 3, lines 4-7; page 5, claim 8	1,2,4,5,7-10
A	IBM Technical Disclosure Bulletin, vol. 23, no. 3, August 1980 (New York, US)	./.

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
22nd March 1985	19 AVR. 1985
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	G.L.M. Kruydenberg

Form PCT/ISA/210 (second sheet) (January 1985)

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
	M.L. Workman: "Optically read and servoed direct-access storage device", pages 1200-1202, see the entire article	1-5,7-10
A	JP, A, 5473610 (FUJITSU) 13 June 1979 & Patents Abstracts of Japan, vol. 3, no. 96, page 38E130, 15 April 1979 see the abstract; figure 2	1,2,4-6,9-10
A	JP, A, 546510 (FUJITSU) 18 January 1979 & Patents Abstracts of Japan, vol. 3, no. 28, page 51E96, 9 March 1979 see the abstract; figures 4-6	1,2,4-6,9,10
A	IBM Technical Disclosure Bulletin, vol. 26, no. 6, November 1983 (New York, US) H.W. Werlich et al.: "Holographically generated high resolution track servo pattern for optical or capacitive readout", pages 2951-2952, see the entire article	1,2,10
A	IBM Technical Disclosure Bulletin, vol. 20, no. 10, March 1978 (New York, US) A.S. Hoagland: "Optical servo of magnetic recording", pages 4108-4109, see the entire article	1,4,5,9,10
A	Patents Abstracts of Japan, vol. 20, no. 182, P-90,854; 20 November 1981 & JP, A, 56111169 (Fujitsu) 2 September 1981	1,4,5,9,10
A	IBM Technical Disclosure Bulletin, vol. 12, no. 4, September 1969 (New York, US) R.E. Kubec et al.: "Track following servo for magnetic recording using luminescent servo tracks", pages 599-600	
A	Patents Abstracts of Japan, vol. 2, no. 20, 9 February 1978, page 11134E77, & JP, A, 52136611 (Fujitsu) 15 November 1977	
A	Patents Abstracts of Japan, vol. 5, no. 73, 15 May 1981, P-61;745 & JP, A, 22266 (Fujitsu) 2 March 1981	
A	Patents Abstracts of Japan, vol. 3, no. 150, 11 December 1979, page 44E158	./.

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

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	& JP, A, 54130004 (Fujitsu) 9 October 1979 --	
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INTERNATIONAL APPLICATION NO. PCT/US 8402085 (SA 8471)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 15/04/85

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		US-A-	4123788	31/10/78
		JP-A-	52124312	19/10/77
		GB-A-	1580986	10/12/80
FR-A- 2315142	14/01/77	None		
JP-A-54073610	13/06/79	None		
JP-A-54006510	18/01/79	None		